

WHAT WE CLAIMED IS:

1. A printing method comprising the steps of:

providing a print head having

5 a plurality of single chromatic nozzle groups for ejecting mutually different chromatic inks, each consisting of plurality of nozzles, and an achromatic nozzle group for ejecting achromatic ink consisting of a greater number of nozzles than each of the single chromatic nozzle groups; and

10 printing images in a monochromatic area on a printing medium with the achromatic ink alone, and in a color area with the chromatic inks, the step of printing images comprising the steps of:

(a) executing regular monochromatic mode printing whereby sub-scans are performed in a first sub-scan mode, and dots are formed along the main scan lines in the monochromatic area;

15 (b) executing lower-edge monochromatic mode printing whereby sub-scans are performed in a second sub-scan mode in which a maximum sub-scan feed increment is less than a maximum sub-scan feed increment of the first sub-scan mode, and dots are formed along the main scan lines in the monochromatic area in the vicinity of a border with the color area;

20 (c) executing upper-edge color mode printing whereby sub-scans are performed in a third sub-scan mode, and dots are formed along the main scan lines in the color area in the vicinity of the border with the monochromatic area; and

25 (d) executing regular color mode printing whereby sub-scans are performed in a fourth sub-scan mode in which a maximum sub-scan feed increment is greater than a maximum sub-scan feed increment of the third sub-scan mode, and dots are formed along the main scan lines in the color area.

2. The printing method according to claim 1, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the nozzles of the achromatic nozzle group are arranged at a nozzle  
5 pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; and  
the printing in each of steps (a), (b), (c) and (d) is interlaced printing.

3. The printing method according to claim 1, wherein the single chromatic nozzle groups have mutually equal numbers of  $Nc$  nozzles  
10 arranged at a nozzle pitch  $kc \times D$ , where  $Nc$  is an integer of 2 or greater,  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the achromatic nozzle group has  $Nm$  nozzles arranged at a nozzle pitch  $km \times D$ , where  $Nm$  is an integer greater than  $Nc$ ,  $km$  is an integer equal to  $kc/J$  and  $J$  is a positive integer; wherein

15 step (a) comprises a step of performing monochromatic mode main scans using the achromatic nozzle group but without using the single chromatic nozzle groups, alternately with the sub-scans;

step (b) comprises a step of performing the monochromatic mode main scans at least  $(km - 1)$  times alternately with the sub-scans;

20 step (c) comprises a step of performing color mode main scans at least  $(kc - 1)$  times using the plurality of single chromatic nozzle groups and a specific achromatic nozzle group, alternately with sub-scans, the specific achromatic nozzle group being selected from the achromatic nozzle group and consisting of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ ; and

25 step (d) comprises a step of performing color mode main scans alternately with the sub-scans.

4. The printing method according to claim 1, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$   
30 is an integer of 2 or greater; wherein

step (b) comprises a step of performing the sub-scans ( $km - 1$ ) times.

5. The printing method according to claim 1, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ ,  
5 where  $kc$  is an integer of 2 or greater; wherein  
step (c) comprises a step of performing the sub-scans ( $kc - 1$ ) times.

6. The printing method according to claim 1, wherein the step (c) comprises a step of:  
10 starting upper-edge color mode printing when a topmost nozzle of the plurality of single chromatic nozzle groups is in a position upside of a border of the monochromatic area and the color area.

7. The printing method according to claim 1, further comprising a step  
15 of:

(e) performing a sub-scan after step (b) and before step (c) such that the print head is placed at a specific position near an upper edge of the color area when a distance between the print head and the upper edge of the color area at the end of step (b) is less than a specific value.

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8. The printing method according to claim 7, wherein step (e) includes a step of:

performing a sub-scan such that the print head is put to a first relative position in relation to the printing medium from a second relative  
25 position at which the print head is located at the end of step (b), when the second relative position falls outside a permissible range of the first relative position, the first relative position being defined to be a position such that when the print head is positioned at the first relative position and step (c) is performed starting from the first relative position, the main scan lines can be  
30 recorded without any gaps all the way from the upper edge of the color area.

9. The printing method according to claim 1, wherein step (a) comprises a step of:

proceeding to step (b) if a first relative position of the print head in relation to the printing medium lies below a second relative position, the first relative position being defined to be a position reached by the print head when a subsequent sub-scan in the first sub-scan mode and all the sub-scans to be performed during step (b) are performed, the second relative position being defined to be a position such that when the print head is positioned at the second relative position and step (c) is performed starting from the second relative position, the main scan lines can be recorded without any gaps all the way from the upper edge of the color area.

10. The printing method according to claim 1, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the first sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $p1 \times D$ , where  $p1$  is an integer constituting a prime with  $km$ .

11. The printing method according to claim 1, wherein the first sub-scan mode is a mode for carrying out a non-constant sub-scan feeding that includes performing repeated combinations of sub-scans in variable feed increments.

12. The printing method according to claim 1, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the fourth sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $q1 \times D$ , where  $q1$  is an integer constituting a prime with  $kc$ .

5        13. The printing method according to claim 1, wherein  
the fourth sub-scan mode is a mode for carrying out a non-constant sub-scan feeding that includes performing repeated combinations of sub-scans in variable feed increments.

10       14. The printing method according to claim 1, wherein  
the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the second sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $p2 \times D$ , where  $p2$  is an integer constituting a prime with  $km$ .  
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15. The printing method according to claim 1, wherein  
the nozzles of the single chromatic nozzle groups are arranged at a  
20 nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the third sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $q2 \times D$ , where  $q2$  is an integer constituting a prime with  $kc$ .

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16. The printing method according to claim 15, wherein  $q2$  is 1.

17. A printing method comprising the steps of:  
providing a print head having

a plurality of single chromatic nozzle groups for ejecting mutually different chromatic inks, each consisting of plurality of nozzles, and an achromatic nozzle group for ejecting achromatic ink consisting of a greater number of nozzles than each of the single chromatic nozzle groups; and

printing images in a monochromatic area on a printing medium with the achromatic ink alone, and in a color area with the chromatic inks, the step of printing images comprising the steps of:

(a) executing regular color mode printing whereby sub-scans are performed in a first sub-scan mode, and dots are formed along the main scan lines in the color area;

(b) executing lower-edge color mode printing whereby sub-scans are performed in a second sub-scan mode in which a maximum sub-scan feed increment is less than a maximum sub-scan feed increment of the first sub-scan mode, and dots are formed along the main scan lines in the color area in the vicinity of the border with the monochromatic area;

(c) executing upper-edge monochromatic mode printing whereby sub-scans are performed in a third sub-scan mode, and dots are formed along the main scan lines in the monochromatic area in the vicinity of a border with the color area; and

(d) executing regular monochromatic mode printing whereby sub-scans are performed in a fourth sub-scan mode in which a maximum sub-scan feed increment is greater than a maximum sub-scan feed increment of the third sub-scan mode, and dots are formed along the main scan lines in the monochromatic area.

18. The printing method according to claim 17, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; and  
the printing in each of steps (a), (b), (c) and (d) is interlaced printing.

5        19. The printing method according to claim 17, wherein the single chromatic nozzle groups have mutually equal numbers of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ , where  $Nc$  is an integer of 2 or greater,  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the achromatic nozzle group has  $Nm$  nozzles arranged at a nozzle pitch  
10     $km \times D$ , where  $Nm$  is an integer greater than  $Nc$ ,  $km$  is an integer equal to  $kc/J$  and  $J$  is a positive integer; wherein

step (a) comprises a step of performing color mode main scans using the plurality of single chromatic nozzle groups and specific achromatic nozzle group, alternately with the sub-scans, the specific achromatic nozzle group  
15    being selected from the achromatic nozzle group and consisting of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ ;

step (b) comprises a step of performing the color mode main scans at least  $(km - 1)$  times alternately with the sub-scans;

step (c) comprises a step of performing monochromatic mode main  
20    scans at least  $(kc - 1)$  times using the achromatic nozzle group but without using the single chromatic nozzle groups, alternately with sub-scans; and

step (d) comprises a step of performing the monochromatic mode main scans alternately with the sub-scans.

25        20. The printing method according to claim 17, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater; wherein

step (b) comprises a step of performing the sub-scans  $(kc - 1)$  times.

21. The printing method according to claim 17, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; wherein

step (c) comprises a step of performing the sub-scans  $(km - 1)$  times.

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22. The printing method according to claim 17, wherein the step (c) comprises a step of:

starting upper-edge monochromatic mode printing when a topmost nozzle of the achromatic nozzle group is in a position upside of a border of the color area and the monochromatic area.

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23. The printing method according to claim 17, comprising a step of:

(e) performing a sub-scan after step (b) and before step (c) such that the print head is placed at a specific position near an upper edge of the monochromatic area when a distance between the print head and the upper edge of the monochromatic area at the end of step (b) is less than a specific value.

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24. The printing method according to claim 23, wherein step (e) includes a step of:

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performing a sub-scan such that the print head is put to a first relative position in relation to the printing medium from a second relative position at which the print head is located at the end of step (b), when the second relative position falls outside a permissible range of the first relative position, the first relative position being defined to be a position such that when the print head is positioned at the first relative position and step (c) is performed starting from the first relative position, the main scan lines can be recorded without any gaps all the way from the upper edge of the monochromatic area.

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25. The printing method according to claim 17, wherein step (a) comprises a step of:

proceeding to step (b) if a first relative position of the print head in relation to the printing medium lies below a second relative position, the first  
5 relative position being defined to be a position reached by the print head when a subsequent sub-scan in the first sub-scan mode and all the sub-scans to be performed during step (b) are performed, the second relative position being defined to be a position such that when the print head is positioned at the second relative position and step (c) is performed starting from the second  
10 relative position, the main scan lines can be recorded without any gaps all the way from the upper edge of the monochromatic area.

26. The printing method according to claim 17, wherein the nozzles of the single chromatic nozzle groups are arranged at a  
15 nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the first sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $q1 \times D$ , where  $q1$  is an integer constituting a prime with  $kc$ .

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27. The printing method according to claim 17, wherein the first sub-scan mode is a mode for carrying out a non-constant sub-scan feeding that includes performing repeated combinations of sub-scans in variable feed increments.

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28. The printing method according to claim 17, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the fourth sub-scan mode is a mode for carrying out a constant sub-scan feeding with constant feed increments of  $p1 \times D$ , where  $p1$  is an integer constituting a prime with  $km$ .

5           29. The printing method according to claim 17, wherein  
the fourth sub-scan mode is a mode for carrying out a non-constant sub-scan feeding that includes performing repeated combinations of sub-scans in variable feed increments.

10           30. The printing method according to claim 17, wherein  
the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the second sub-scan mode is a mode for carrying out a constant sub-  
15 scan feeding with constant feed increments of  $q2 \times D$ , where  $q2$  is an integer constituting a prime with  $kc$ .

31. The printing method according to claim 30, wherein  $q2$  is 1.

20           32. The printing method according to claim 17, wherein  
the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines; and

the third sub-scan mode is a mode for carrying out a constant sub-scan  
25 feeding with constant feed increments of  $p2 \times D$ , where  $p2$  is an integer constituting a prime with  $km$ .

33. A printing apparatus which prints images in a monochromatic area on a printing medium with an achromatic ink alone, and in a color area

with chromatic inks, by ejecting ink drops from a nozzle to deposit the ink drops on the printing medium to form dots, comprising:

a printing head having:

a plurality of single chromatic nozzle groups for ejecting

5 mutually different chromatic inks, each consisting of plurality of nozzles, and

an achromatic nozzle group for ejecting achromatic ink

consisting of a greater number of nozzles than each of the single chromatic nozzle groups;

10 a main scan drive unit that moves at least one of the printing head and the printing medium to perform main scanning;

a sub-scan drive unit that moves at least one of the printing head and the printing medium in a direction that intersects a main scanning direction to perform sub-scanning; and

15 a control unit that controls the printing head, the main scan drive unit and the sub-scan drive unit,

wherein the control unit has:

(a) a regular monochromatic mode unit that executes regular monochromatic mode printing whereby sub-scans are performed in a first sub-scan mode, and dots are formed along the main scan lines in the  
20 monochromatic area;

(b) a lower-edge monochromatic mode unit that executes lower-edge monochromatic mode printing whereby sub-scans are performed in a second sub-scan mode in which a maximum sub-scan feed increment is less than a maximum sub-scan feed increment of the first sub-scan mode, and dots are  
25 formed along the main scan lines in the monochromatic area in the vicinity of a border with the color area;

(c) a upper-edge color mode unit that executes upper-edge color mode printing whereby sub-scans are performed in a third sub-scan mode, and dots are formed along the main scan lines in the color area in the vicinity of the  
30 border with the monochromatic area; and

(d) a regular color mode unit that executes regular color mode printing whereby sub-scans are performed in a fourth sub-scan mode in which a maximum sub-scan feed increment is greater than a maximum sub-scan feed increment of the third sub-scan mode, and dots are formed along the main scan lines in the color area.

34. The printing apparatus according to claim 33, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; and

the regular monochromatic mode unit, the lower-edge monochromatic mode unit, the upper-edge color mode unit and the regular color mode unit each executes interlaced printing.

35. The printing apparatus according to claim 33, wherein the single chromatic nozzle groups have mutually equal numbers of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ , where  $Nc$  is an integer of 2 or greater,  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;

the achromatic nozzle group has  $Nm$  nozzles arranged at a nozzle pitch  $km \times D$ , where  $Nm$  is an integer greater than  $Nc$ ,  $km$  is an integer equal to  $kc/J$  and  $J$  is a positive integer; wherein

the regular monochromatic mode unit performs monochromatic mode main scans using the achromatic nozzle group but without using the single chromatic nozzle groups, alternately with the sub-scans;

the lower-edge monochromatic mode unit performs the monochromatic mode main scans at least  $(km - 1)$  times alternately with the sub-scans;

the upper-edge color mode unit performs color mode main scans at least  $(kc - 1)$  times using the plurality of single chromatic nozzle groups and a specific achromatic nozzle group, alternately with sub-scans, the specific

achromatic nozzle group being selected from the achromatic nozzle group and consisting of  $N_c$  nozzles arranged at a nozzle pitch  $kc \times D$  and

the regular color mode unit performs color mode main scans alternately with the sub-scans.

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36. The printing apparatus according to claim 33, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; wherein

the lower-edge monochromatic mode unit performs the sub-scans ( $km - 1$ ) times.

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37. The printing apparatus according to claim 33, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater; wherein

the upper-edge color mode unit performs the sub-scans ( $kc - 1$ ) times.

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38. The printing apparatus according to claim 33, wherein the upper-edge color mode unit starts upper-edge color mode printing when a topmost nozzle of the plurality of single chromatic nozzle groups is in a position upside of a border of the monochromatic area and the color area.

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39. The printing apparatus according to claim 35, wherein the plurality of single chromatic nozzle groups comprise:

a cyan nozzle group for ejecting a cyan ink;

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a magenta nozzle group for ejecting a magenta ink; and

a yellow nozzle group for ejecting a yellow ink,

the cyan nozzle group, magenta nozzle group, and yellow nozzle group are disposed in the order indicated in the direction of sub-scanning;

the achromatic nozzle group are equipped with  $N_c \times 3$  nozzles arranged at a nozzle pitch  $kc \times D$  and are disposed in the area for

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accommodating the nozzles cyan nozzle group, magenta nozzle group, and yellow nozzle group; and

the specific achromatic nozzle group is disposed in the area for accommodating the nozzles of the cyan nozzle group in the direction of sub-scanning.

40. The printing apparatus according to claim 33, wherein the control unit further comprises:

a position adjusting feed unit that performs a sub-scan such that the print head is placed at a specific position near an upper edge of the color area when a distance between the print head and the upper edge of the color area at the end of lower-edge monochromatic mode printing is less than a specific value.

41. The printing apparatus according to claim 40, wherein the position adjusting feed unit performs the sub-scan such that the print head is put to a first relative position in relation to the printing medium from a second relative position at which the print head is located at the end of lower-edge monochromatic mode printing, when the second relative position falls outside a permissible range of the first relative position, the first relative position being defined to be a position such that when the print head is positioned at the first relative position at the end of lower-edge monochromatic mode printing and upper-edge color mode printing is performed starting from the first relative position, the main scan lines can be recorded without any gaps all the way from the upper edge of the color area.

42. The printing apparatus according to claim 33, wherein the regular monochromatic mode unit proceeds to lower-edge monochromatic mode printing in case that a first relative position of the print head in relation to

the printing medium, assuming that a subsequent sub-scan based on the first sub-scan mode and all the sub-scans to be performed during lower-edge monochromatic mode printing are performed, lies below a second relative position of the print head in relation to the printing medium in which the main scan lines can be recorded without any intervals all the way from the upper edge of the color area, assuming that upper-edge color mode printing is performed starting from the first relative position.

43. A printing apparatus which prints images in a monochromatic area on a printing medium with an achromatic ink alone, and in a color area with chromatic inks, by ejecting ink drops from a nozzle to deposit the ink drops on the printing medium to form dots, comprising:

a printing head having:

a plurality of single chromatic nozzle groups for ejecting mutually different chromatic inks, each consisting of plurality of nozzles, and an achromatic nozzle group for ejecting achromatic ink consisting of a greater number of nozzles than each of the single chromatic nozzle groups;

a main scan drive unit that moves at least one of the printing head and the printing medium to perform main scanning;

a sub-scan drive unit that moves at least one of the printing head and the printing medium in a direction that intersects a main scanning direction to perform sub-scanning; and

a control unit that controls the printing head, the main scan drive unit and the sub-scan drive unit,

wherein the control unit has:

(a) a regular color mode unit that executes regular color mode printing whereby sub-scans are performed in a first sub-scan mode, and dots are formed along the main scan lines in the color area;

(b) a lower-edge color mode unit that executes lower-edge color mode printing whereby sub-scans are performed in a second sub-scan mode in which a maximum sub-scan feed increment is less than a maximum sub-scan feed increment of the first sub-scan mode, and dots are formed along the  
5 main scan lines in the color area in the vicinity of the border with the monochromatic area;

(c) a upper-edge monochromatic mode unit that executes upper-edge monochromatic mode printing whereby sub-scans are performed in a third sub-scan mode, and dots are formed along the main scan lines in the  
10 monochromatic area in the vicinity of a border with the color area; and

(d) a regular monochromatic mode unit that executes regular monochromatic mode printing whereby sub-scans are performed in a fourth sub-scan mode in which a maximum sub-scan feed increment is greater than a maximum sub-scan feed increment of the third sub-scan mode, and dots are  
15 formed along the main scan lines in the monochromatic area.

44. The printing apparatus according to claim 43, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ , where  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;  
20 the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  $km$  is an integer of 2 or greater; and

the regular color mode unit, the lower-edge color mode unit, the upper-edge, monochromatic mode unit and the regular monochromatic mode unit each executes interlaced printing.  
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45. The printing apparatus according to claim 44, wherein the single chromatic nozzle groups have mutually equal numbers of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ , where  $Nc$  is an integer of 2 or greater,  $kc$  is an integer of 2 or greater and  $D$  is a pitch of main scan lines;



the achromatic nozzle group has  $Nm$  nozzles arranged at a nozzle pitch  $km \times D$ , where  $Nm$  is an integer greater than  $Nc$ ,  $km$  is an integer equal to  $kc/J$  and  $J$  is a positive integer; wherein

5 the regular color mode unit performs color mode main scans using the plurality of single chromatic nozzle groups and specific achromatic nozzle group alternately with the sub-scans, the specific achromatic nozzle group being selected from the achromatic nozzle group and consisting of  $Nc$  nozzles arranged at a nozzle pitch  $kc \times D$ ;

10 the lower-edge color mode unit performs the color mode main scans at least  $(km - 1)$  times alternately with the sub-scans;

the upper-edge monochromatic mode unit performs monochromatic mode main scans using the achromatic nozzle group but without using the single chromatic nozzle groups at least  $(kc - 1)$  times alternately with sub-scans; and

15 the regular monochromatic mode unit performs the monochromatic mode main scans alternately with the sub-scans.

46. The printing apparatus according to claim 43, wherein the nozzles of the single chromatic nozzle groups are arranged at a nozzle pitch  $kc \times D$ ,  
20 where  $kc$  is an integer of 2 or greater; wherein

the lower-edge color mode unit performs the sub-scans  $(kc - 1)$  times.

47. The printing apparatus according to claim 43, wherein the nozzles of the achromatic nozzle group are arranged at a nozzle pitch  $km \times D$ , where  
25  $km$  is an integer of 2 or greater; wherein

the upper-edge monochromatic mode unit performs the sub-scans  $(km - 1)$  times.

48. The printing apparatus according to claim 43, wherein

the upper-edge monochromatic mode unit starts upper-edge monochromatic mode printing when a topmost nozzle of the achromatic nozzle group is in a position upside of a border of the color area and the monochromatic area.

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49. The printing apparatus according to claim 45, wherein the plurality of single chromatic nozzle groups comprise:

a cyan nozzle group for ejecting a cyan ink;

a magenta nozzle group for ejecting a magenta ink; and

10 a yellow nozzle group for ejecting a yellow ink,

the cyan nozzle group, magenta nozzle group, and yellow nozzle group are disposed in the order indicated in the direction of sub-scanning;

the achromatic nozzle group are equipped with  $N_c \times 3$  nozzles arranged at a nozzle pitch  $k_c \times D$  and are disposed in the area for

15 accommodating the nozzles cyan nozzle group, magenta nozzle group, and yellow nozzle group; and

the specific achromatic nozzle group is disposed in the area for accommodating the nozzles of the cyan nozzle group in the direction of sub-scanning.

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50. The printing apparatus according to claim 43, wherein the control unit further comprises:

a position adjusting feed unit that performs a sub-scan whereby the print head is placed at a specific position near an upper edge of the  
25 monochromatic area when the distance between the print head and the upper edge of the monochromatic area at the end of lower-edge color mode printing is less than a specific value.

51. The printing apparatus according to claim 50, wherein the position  
30 adjusting feed unit performs the sub-scan from a second relative position of

the print head in relation to the printing medium to a first relative position of the print head in relation to the printing medium, when the second relative position at the end of lower-edge color mode printing falls outside an allowed range of the first relative position in which the main scan lines can be  
5 recorded without any intervals all the way from the upper edge of the monochromatic area, assuming that upper-edge monochromatic mode printing is performed starting from the first relative position.

52. The printing apparatus according to claim 43, wherein the regular  
10 color mode unit proceeds to lower-edge color mode printing in case that a first relative position of the print head in relation to the printing medium, assuming that a subsequent sub-scan based on the first sub-scan mode and all the sub-scans to be performed during lower-edge color mode printing are performed, lies below a second relative position of the print head in relation  
15 to the printing medium in which the main scan lines can be recorded without any intervals all the way from the upper edge of the monochromatic area, assuming that upper-edge monochromatic mode printing is performed starting from the second relative position.

20 53. A computer program product for printing images in a monochromatic area on a printing medium with the achromatic ink alone, and in a color area with the chromatic inks, using a computer, the computer being connected with a printing device having a printing head equipped with  
a plurality of single chromatic nozzle groups for ejecting  
25 mutually different chromatic inks, each consisting of plurality of nozzles, and  
an achromatic nozzle group for ejecting achromatic ink  
consisting of a greater number of nozzles than each of the single chromatic  
nozzle groups, the computer program product comprising:  
a computer readable medium; and

a computer program stored on the computer readable medium, the computer program comprising:

(a) a regular monochromatic mode program for causing the computer to execute regular monochromatic mode printing whereby sub-scans are performed in a first sub-scan mode, and dots are formed along the main scan lines in the monochromatic area;

(b) a lower-edge monochromatic mode program for causing the computer to execute lower-edge monochromatic mode printing whereby sub-scans are performed in a second sub-scan mode in which a maximum sub-scan feed increment is less than a maximum sub-scan feed increment of the first sub-scan mode, and dots are formed along the main scan lines in the monochromatic area in the vicinity of a border with the color area;

(c) a upper-edge color mode program for causing the computer to execute upper-edge color mode printing whereby sub-scans are performed in a third sub-scan mode, and dots are formed along the main scan lines in the color area in the vicinity of the border with the monochromatic area; and

(d) a regular color mode program for causing the computer to execute regular color mode printing whereby sub-scans are performed in a fourth sub-scan mode in which a maximum sub-scan feed increment is greater than a maximum sub-scan feed increment of the third sub-scan mode, and dots are formed along the main scan lines in the color area.

54. A computer program product for printing images in a monochromatic area on a printing medium with the achromatic ink alone, and in a color area with the chromatic inks, using a computer, the computer being connected with a printing device having a printing head equipped with a plurality of single chromatic nozzle groups for ejecting mutually different chromatic inks, each consisting of plurality of nozzles, and

an achromatic nozzle group for ejecting achromatic ink  
consisting of a greater number of nozzles than each of the single chromatic  
nozzle groups, the computer program product comprising:

a computer readable medium; and

5 a computer program stored on the computer readable medium, the  
computer program comprising:

(a) a regular color mode program for causing the computer to execute  
regular color mode printing whereby sub-scans are performed in a first sub-  
scan mode, and dots are formed along the main scan lines in the color area;

10 (b) a lower-edge color mode program for causing the computer to  
execute lower-edge color mode printing whereby sub-scans are performed in a  
second sub-scan mode in which a maximum sub-scan feed increment is less  
than a maximum sub-scan feed increment of the first sub-scan mode, and  
dots are formed along the main scan lines in the color area in the vicinity of  
15 the border with the monochromatic area;

(c) a upper-edge monochromatic mode program for causing the  
computer to execute upper-edge monochromatic mode printing whereby sub-  
scans are performed in a third sub-scan mode, and dots are formed along the  
main scan lines in the monochromatic area in the vicinity of a border with  
20 the color area; and

(d) a regular monochromatic mode program for causing the computer to  
execute regular monochromatic mode printing whereby sub-scans are  
performed in a fourth sub-scan mode in which a maximum sub-scan feed  
increment is greater than a maximum sub-scan feed increment of the third  
25 sub-scan mode, and dots are formed along the main scan lines in the  
monochromatic area.